

**APPENDIX M:
SUPPLEMENTAL ALTERNATIVE ANALYSIS
T-HEAD GROIN FIELD AND REDUCED FILL**

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**APPENDIX M:
SUPPLEMENTAL ALTERNATIVE ANALYSIS
T-HEAD GROIN FIELD AND REDUCED FILL**

1.0 INTRODUCTION

In response to public comments relative to the Draft Final SEIS for the Phipps Ocean Park Beach Restoration Project dated January 23, 2003, an additional structure alternative is evaluated in detail. Specifically, Appendix M expands the alternatives considered in the FSEIS to provide a detailed evaluation of an additional alternative designated the T-Head Groin Field and Reduced Fill Alternative.

To the extent possible, the objectives of the T-Head Groin Field and Reduced Fill Alternative are to: (1) satisfy the project purposes as defined by the Applicant; (2) reduce the area of nearshore hardbottom impacted by the project when compared to the Applicant's Preferred Alternative by construction of T-head groins and reducing the total project fill volume; and (3) to retain greater sand volume within the project area once placed and thereby reduce the need for renourishment.

This Appendix includes a description and evaluation of three variations of the T-Head Groin and Reduced Fill Alternative, designated Concepts 1, 2 and 3. The applicable engineering principles and criteria used to evaluate the feasibility of the supplemental alternative are included along with the modeling analysis and results, the expected environmental consequences, and conclusions as to the alternative's feasibility in meeting the Applicant's stated project purposes.

**2.0 DESCRIPTION OF T-HEAD GROIN FIELD AND REDUCED FILL
ALTERNATIVE**

Three T-Head Groin and Reduced Fill configurations are evaluated in Appendix M and are designated Concepts 1, 2 and 3. Figures representing all three concepts are located at the end of this Appendix. The fill volume proposed in the Applicant's Preferred Alternative is 1.5 million cubic yards of sand and all the T-Head Groin and Reduced Fill concepts decrease the total volume, compared to the Applicant's Preferred Alternative, by at least 46% and as high as 50%. In all three concepts, the identical T-head groin configuration was evaluated, consisting of a "central groin" in the vicinity of DNR Monument R-119.25 and a group of three short groins approximately 250 feet apart located between DNR Monuments R-116.5 and R-117.25, immediately south of Sloan's Curve. All three concepts include a "base fill", which entails placement of a total volume of 750,000 cubic yards of sand to yield a 200-foot wide berm over 7,039 feet of shoreline between DNR Monuments R-126 and R-119.25.

In summary, the three T-Head Groin Concepts are as follows:

Concept 1- No Fill in North Half: The total fill volume for Concept 1 is 750,000 cubic yards or 50% less than the volume used in the Applicant's Preferred Alternative. The fill would be placed only in the area south of the central groin extending south from DNR Monument R-119.25 to R-126. To reduce potential nearshore hardbottom impacts in the northern end of the project area, no fill is proposed in Concept 1 between the central groin, located at DNR Monument R-119.25 and the group of the three northern most T-Head groins, located at about DNR Monument R-117. A plan view depiction of Concept 1 – designated Figures M 1.0, M 1.1 and M 1.2 -- is included at the back of this Appendix showing the overall design and detailed plan views of the T-Head Groin locations. GENESIS Model run results for years 2, 4, 6 and 8 following Concept 1 construction are designated as Figures M 1.3 to M 1.6.

Concept 2 – Base Fill Plus Minimal Fill in the North Half of the Project Area: The total fill volume for Concept 2 is 805,000 cubic yards or about 46% less than the volume used in the Applicant's Preferred Alternative. This volume is the greatest volume modeled for any of the three T-Head Groin concepts. Concept 2 includes the 750,000 cubic yards of “base fill” plus and an additional 65,000 cubic yards placed throughout the northern half of the project area, beginning at DNR Monument R-119.25 and extending north to DNR Monument R-116. This placement will pre-fill the gap between the central groin at DNR Monument R-119.25 and the group of three T-head groins at about DNR Monument R-117. This northern fill volume would extend the MHWL about 30 feet seaward. A plan view depiction of Concept 2 – designated Figures M 2.0, M 2.1 and M 2.2 -- is included at the back of this Appendix showing the overall design and detailed plan views of the T-Head Groin locations. GENESIS Model run results for years 2, 4, 6 and 8 following Concept 2 construction are designated as Figures M 2.3 to M 2.6.

Concept 3 – Base Fill Plus Minimal Fill in the North Groin Field: As shown in Figures M3a – M3c, Concept 3 calls for minimal fill placement to extend the MHWL about 30 feet seaward in the groin field; no fill would be placed between the groin field and the central groin. The total fill volume for Concept 3 is 765,000 cubic yards or 49% less than the volume used in the Applicant's Preferred Alternative. Concept 3 includes the 750,000 cubic yard “base fill” plus an additional 15,000 cubic yards of fill within the group of three T-head groins located at about DNR Monument R-117. This limited fill placement is intended to pre-fill the groin field and extend the MHWL about 30 feet seaward. No fill would be placed between the central groin at DNR Monument R-119.25 and the group of three T-head groins at about DNR Monument R-117. A plan view depiction of Concept 3 – designated Figures M 3.0, M 3.1 and M 3.2 -- is included at the back of this Appendix showing the overall design and detailed plan views of the T-Head Groin locations. GENESIS Model run results for years 2, 4, 6 and 8 following Concept 3 construction are designated as Figures M 3.3 to M 3.6.

3.0 APPLICABLE ENGINEERING PRINCIPLES

In appropriate circumstances, groins can be effective and economical for coastal erosion control. However, on sand-depleted shorelines, groin fields are most effective when sand is also placed to establish the beach within the groin field and re-establish, at least in part, longshore sediment transport processes. When combined with fill placement, groins can retard potential longshore transport out of the placement area and maintain a reasonable beach width for an extended period of time, effectively lengthening the re-nourishment interval of a beach fill project. Generally, without the addition of a significant volume of sand to “pre-fill” the system, unfilled groins can exacerbate downdrift erosion by impounding what little sand may be available. All three concepts evaluated in this Appendix include the placement of some sand, but at volumes 46% to 50% less than the volume proposed in the Applicant’s Preferred Alternative.

In general, where erosion is attributable to a longshore sediment transport deficit, a groin field is expected to decrease erosion rates and improve shoreline stability updrift of the individual groins, if, and only if, adequate longshore transport exists or the structures are overfilled with sand at the time of construction and maintained in this filled state (fully empounded) through subsequent nourishment. When unfilled or partially filled groin fields actively trap sand, the groins ***increase erosion*** downdrift of the structures. Pursuant to Florida Administrative Code Chapter 62B-41.005 (4) and (5), structures which interfere with the natural longshore and onshore/offshore movement of sediments are not allowed unless there is a net positive benefit to the coastal system and “mitigation” is provided for any adverse impacts. In the case of groin fields, “mitigation” for downdrift impacts commonly consists of a FDEP requirement to maintain the groins in a ***fully impounded condition***. Achieving this fully impounded condition throughout the life of the project requires overfilling at the time of construction and subsequent periodic renourishment. For the partially-filled groin field configuration considered in this Appendix, the groins are expected to become exposed within the first year of construction. It would not be cost effective to re-nourish and re-fill the groin field every year to compensate for the expected longshore/crossshore losses in the groin field.

The protective value of groins is almost entirely attributable to the added beach width and associated sand volume held in place by the groins. Without this added beach, groins provide insignificant protection to upland improvements from the effects of storm surge and cross-shore transport. This insignificant protection is attributable to the very limited extent to which groins block cross-shore transport solely within the footprint of each groin, similar to a revetment. Between groins, cross-shore transport is unimpeded. The protection afforded by groins may be increased by a “T-head”, but again, this effect is limited to the footprint of the T-head groin. For the “T-head groin” alternatives considered herein, the footprint of the T-head groins might reduce wave energy over the roughly 490 feet of beach in the lee (west) of the structures; however, this effect is expected to be insignificant in comparison to the surrounding erosion of the unprotected 1,600 feet of shoreline updrift and between the groins. As a result of these discontinuous effects, the groins are not expected to provide any significant protection to upland improvements. Appendix N contains an analysis of the storm protection provided by the Applicant’s Preferred Alternative and comparison to the No

Action Alternative based upon the risk of damage to upland structures and including the influence of seawalls and rock outcrops in the Project area.

Currently, the most widely accepted groin designs incorporate a short, shore-parallel T-head structure on a shore-perpendicular “trunk” section with one or more weirs that provide some level of permeability in the structures so as not to completely interrupt the longshore transport of sand. In conjunction with beach nourishment projects, short, semi-permeable, T-head groins or groin fields may be appropriate to address one or more of the following specific situations:

- 1) End Effects: When used as terminal structures, groins can reduce the rate of losses due to longshore transport associated with end-effects at the downdrift limits of fill placement, or
- 2) Hot Spots: Groins can minimize the advance fill volume and re-nourishment requirements at a "hot spot", or
- 3) Reduced Seaward Limits of Fill: By reducing longshore transport losses in a beach fill area, groins can reduce advance fill requirements and reduce the seaward limits of the toe of fill (TOF) thus avoiding or reducing impacts to nearshore hardbottom, or
- 4) Reduced Spreading of Fill: Groins reduce longshore transport or spreading of fill material thereby potentially reducing impacts to adjacent nearshore hardbottom.

For the Phipps Ocean Park Beach Restoration Project, a "hot spot" currently exists in the vicinity of DNR Monument R-116 + 500 feet to R-117. This hot spot is sand-starved and the net longshore transport to the south is diminished or non-existent as a result of the extensive shoreline armoring and groins to the north. Without sand placement, this hot spot at the northern end of the Project would continue to exist. The severity of sand-starvation in this area is evidenced by the extensively exposed nearshore hardbottom in the northern portion of the Project Area. Consequently, all three T-Head Groin and Reduced Fill concepts include the placement of some sand to at least partially fill the groin field and address the Phipps Project Area hot spot.

4.0 MODELING METHODS AND RESULTS

The performance of the T-Head Groin and Reduced Fill Alternative was evaluated using the USACE GENESIS numerical model (Version 3.0), as calibrated for evaluation of the Applicant's Preferred Alternative, and through the application of established coastal engineering principles and best professional judgment. The GENESIS model was used to predict the shoreline response of the three T-Head Groin and Reduced Fill configurations described above. The results of the GENESIS model runs for each concept are included as Figures M 1.3 to M 1.6 for Concept 1; M 2.3 to M 2.6 for Concept 2; and M 3.3 to M 3.6 for Concept 3. The model results are included at the end of this document.

Regardless of the concept evaluated, the GENESIS Model analysis for all three concepts is similar in several important respects. For all three concepts, 750,000 cubic yards of sand would be placed south of the central groin from DNR Monument R-119.25 to R-126 in an identical fill template. In this placement area, the shoreline response is most immediate and significant within the first 1,000 feet south of the central groin, a reach extending from about DNR Monuments R-119.25 to R-120.25. In this 1,000-foot reach, the shoreline will essentially recede to the pre-fill conditions within four years following construction. In the area further south, from about DNR Monument R-120.25 to R-126, approximately 50% of the total fill volume will be lost within the first four years following construction, triggering the need for renourishment of the project. To maintain the beach for the Applicant's stated project purposes, a renourishment interval of three years would be necessary for all three T-Head Groin and Reduced Fill concepts.

In all cases, a small accretionary tombolo would form on the updrift or north side of the group of three T-head groins within the first year following construction. Immediately south of each groin (in the group of three T-head groins located at about DNR Monument R-117), the shoreline would erode to a point landward of the pre-construction shoreline within the first year. This predicted shoreline recession south of the groins is not unexpected and is directly attributable to the localized effect of the groins.

In concepts 1 and 3, no fill is placed between the central groin, located at DNR Monument R-119.25, and the group of three groins located at about DNR Monument R-117. In these cases, the shoreline north of the central groin would not accrete because of the minimal longshore sediment transport into the Project Area. (See Section 3.2.3 which concludes that the armored shoreline and groins north of the project area and other updrift shoreline conditions substantially limit the longshore sediment transport entering the project area). For Concept 2, where a limited fill volume is added between the central groin at DNR Monument R-119.25 and the group of three groins at about DNR Monument R-117, the shoreline is expected to erode to its the pre-project location within the first year following construction.

Reducing the fill volume by 46% to 50% or to a volume between 750,000 and 805,000 cubic yards for the three T-head groin concepts would substantially increase the re-nourishment frequency for these projects, when compared to the Applicant's Preferred Alternative. For all alternatives, the maximum re-nourishment frequency is prescribed by the point in time in which the fill within Phipps Ocean Park has substantially eroded to the pre-fill condition – as predicted by the GENESIS model. For the T-head groin concepts, the fill within the Park is expected to erode to the pre-fill conditions between 2 and 4 years after each nourishment event; a re-nourishment interval of 3 years is anticipated. All three of the modeled T-Head Groin and Reduced Fill concepts would require re-nourishment every three years, as opposed to every eight years for the Applicant's Preferred Alternative. Over the life of the project, the almost three-fold increase in renourishment events can reasonably be expected to increase the project costs and, because of the substantial increase in renourishment events, increase the cumulative adverse impacts of the project on offshore borrow area resources, water quality, nearshore hardbottom, and other resources.

Table M-1 illustrates the total sand volume over the 50-year project life required to maintain the Applicant's Preferred Alternative and each of the T-head Groin and reduced Fill Concepts and the annualized cost of each alternative. The results of this analysis clearly show that while the initial fill volumes have been reduced by a substantial margin, this advantage is almost completely erased in the long-term.

Table M - 1 Comparison of Fill Volumes, Renourishment Intervals and Project Costs over 50-year Project Life, Applicant's Preferred Alternative vs. T-Head Groin Concepts 1 - 3

Table M-1 Alternative Description	⁽¹⁾ Length of Maintained Beach (feet)	Total Volume Placed Over 50 Years (c.y.)	⁽³⁾ Annualized Beach Fill Cost Over 50 Years (IRR = 4%)	Renourish- ment Interval (years)	Number of Dredge Operations Over 50 Years
<i>Applicant's Preferred Alternative (APA)</i> 1.5 Million Cubic Yard Beach Fill	10,000	6,300,000 (100% of APA)	\$778,300	8	6
T-Head Groin Concept 1 750,000 Cubic Yard Beach Fill	5,000	5,550,000 (88% of APA)	\$889,500	3	16
T-Head Groin Concept 2 805,000 Cubic Yard Beach Fill	5,000	6,485,000 ⁽²⁾ (103% of APA)	\$969,200	3	16
T-Head Groin Concept 3 765,000 Cubic Yard Beach Fill	5,000	5,805,000 ⁽²⁾ (92% of APA)	\$911,200	3	16
(1) Length is for that equivalent level of storm protection afforded by APA. (2) Volume includes minimal fill north of central groin. (3) Annual cost of groin structures (~\$105,000/year) is not included.					

Note that with the T-Head Groin Concepts, the fill placed between Monument R-119 and Monument R-121 is predicted to be nearly all lost by erosion within four years (see Figure M1.4); maintenance of this segment of beach is not expected to be reasonably achieved by the T-Head Groin Concepts without re-nourishment every three years. However, with the T-Head Groin Concepts even at an eight-year re-nourishment frequency, (a) some of the restored beach is expected to remain after eight years between Monument R-122 and Monument R-126, and (b) the beach between Monuments between R-124.5 and R-126 (southernmost 1500 feet of Project area) is predicted to remain relatively stable. With the T-Head Groin Concepts, the performance of this southernmost 1500 feet of the Project area (R-124.5 to R-126) is predicted to be nearly the same as for the applicant's Preferred Alternative (see Figures 2.5a-2.5d). Ultimately, as summarized in Table M-1, the T-Head Groin Concepts are predicted to maintain approximately 5,000 feet of beach of which only 300 feet are within the public beach access area of Phipps Ocean Park; however, this 300 feet of Park shoreline is expected to erode to existing conditions within 2 years. The Applicant's Preferred Alternative is predicted to maintain 10,000 feet of beach including all of the 600 feet of public beach. Similarly, any of the T-Head Groin Concepts are expected to provide only about 50 percent of the storm damage reduction benefits as compared to the Applicant's Preferred Alternative.

The Applicant's Preferred Alternative is estimated to have an initial cost of \$8.3 million and an annual cost of \$0.84 million; annual storm damage reduction benefits are estimated at \$1.43 million (ATM 1998). ***Based solely on storm damage reduction benefits***, the Applicant's Preferred Alternative is estimated to have a benefit-cost ratio of 1.7 and, as such, is economically justified. Comparably, the T-Head Groin Concepts are estimated to have an initial cost of \$6.5 million and an annual cost of \$1.0 million; annual storm damage reduction benefits are estimated at \$0.72 million. ***Based solely on storm damage reduction benefits***, the T-Head Groin Concepts are estimated to have a benefit-cost ratio of 0.7 and, as such, are not economically justified.

In general, all of the T-Head Groin concepts are expected to realize at least equivalent losses as the Applicant's Preferred Alternative; these losses are attributable to the longshore transport deficit in the Project Area, which is "made-up" through erosion of the placed fill. Over the 50-year life of the project, the T-Head Groin Concept 1 requires only slightly less in total placed sand volume when compared to the Applicant's Preferred Alternative, due entirely to the reduced initial fill volume of 750,000 cubic yards. Concepts 2 and 3 are expected to require greater fill than Concept 1 due to the inefficiencies associated with attempts to maintain a narrow beach north of the central groin. Concept 1 is expected to require 88% of the fill volume of the Applicant's Preferred Alternative, a reduction of 12% in volume, while Concept 3 requires 92% of the preferred fill volume, a reduction of only 8% over the 50-year project life. The total required fill volume for Concept 2 may *exceed* that of the Applicant's Preferred Alternative.

Even if the T-Head Groin and Reduced Fill Alternative fill volumes were substantially less over the 50-year life of the project, the significance of the almost three-fold increase in the renourishment frequency cannot be overlooked in terms of cost or the impact on the human or natural environmental. A dredging frequency every three years would impose a substantial

administrative cost and management burden on the project sponsor and State and federal agencies with permitting responsibilities, as each project is designed, permitted, bid and constructed. The beach and the public would also fare worse under the burden of a major construction project every three years, requiring closure of the beach and the frequent eyesore of heavy equipment and construction on the shoreline. Environmentally, the impact of the greater nourishment frequency over the 50-year project life can reasonably be expected to exceed that of the Applicant's Preferred Alternative, as borrow areas and the beach placement areas are disturbed by dredging, and placement operation, which inherently expose these areas to elevated turbidity and reburial of resources.

5.0 OVERALL FEASIBILITY ANALYSIS

As applied to the alternatives considered in Section 2.0 of the FSEIS, the feasibility of an alternative is evaluated using two fundamental criteria: (1) The extent to which the alternative will likely satisfy the project purposes, as stated by the Applicant; and (2) the extent to which the alternative is cost-effective.

In general, both criteria must be met for the alternative to be considered feasible. Relative to the Applicant's stated project purposes, none of the three T-Head Groin and Reduced Fill concepts evaluated in this Appendix are considered feasible.

As identified in Section 1.2 of the FSEIS, the Applicant's stated project purposes are:

1. To partially mitigate for the long-term erosion impacts of Lake Worth Inlet and the armored coastline north of the Project area;
2. To provide and maintain storm protection to upland improvements, structures, and infrastructure;
3. To restore and maintain the beach for public recreational use, thus benefiting the local economy and creating a public asset; and
4. To restore and maintain the beach for marine turtle nesting habitat."

Because of the substantially reduced fill volume and the absence of significant longshore transport of sand into the Project Area, the T-Head Groin and Reduced Fill concepts would not effectively mitigate for the long-term erosion impacts of Lake Worth Inlet and the armored coastline north of the Project area. By substantially reducing the initial beach fill volume, the T-Head Groin and Reduced Fill concepts can reduce initial nearshore hardbottom impacts by about 1% for Concept 2 to as much as 64% for Concept 1, as compared to the Applicant's Preferred Alternative. However, the limited fill placement area north of the T-head groin field limits the extent to which the downdrift impacts Lake Worth Inlet and the armored coastline north of the project area are mitigated, reduces the recreational beach area created, and limits the extent to which marine turtle nesting habitat is restored. The T-Head Groin and Reduced Fill Alternative does provide some protection to upland improvements, structures, and infrastructure, but because the sand volume and berm width are substantially reduced, the level of storm protection will not equal that provided of the Applicant's Preferred Alternative. Based on the length of shoreline restored south on the central groin, the T-Head

Groin and Reduced Fill Alternative does appear to at least partially address some the Applicant's stated project purposes in this limited area.

With respect to the Applicant's storm damage reduction objective, the T-Head Groin and Reduced Fill Alternative is less effective than the Applicant's Preferred Alternative because the groins are not expected to trap any significant quantity of sand. The longshore sediment transport along the project area shoreline is deficient, limiting the effectiveness of the groins and forcing the high frequency of renourishment to maintain even a modest dry beach area. Beyond the localized "revetment" effect associated with the T-head groin, the groins are not expected to provide significant sand retention or storm damage reduction benefits. In the absence of sand placement north of the central groin, little or no significant storm protection would be provided in this area. While the level of storm protection is less than that provided by the Applicant's Preferred Alternative, the T-Head Groin and Reduced Fill Alternative does appear to reduce the direct impact of the project to nearshore hardground resources.

With respect to restoration of a sandy recreational beach, the T-Head Groin and Reduced Fill Alternative does expand the beach over approximately 69% of the Project Area restored, however, this beach erodes faster than the Applicant's Preferred Alternative and leaves 31% of the project area unnourished. Significantly, the re-nourishment frequency for the T-Head Groin and Reduced Fill Alternative is expected to be every three years, requiring the frequent presence of construction equipment on the beach and the unavoidable limits on public access to the Phipps Ocean Park Beach during these dredging and placement operations. Due to limited longshore sediment transport, however, the groins are not expected to trap any significant quantity of sand or substantially improve the beach for recreational use. (The performance of the T-Head Groin and Reduced Fill Alternative with respect to storm damage reduction benefits is discussed in Section 3.0 in Appendix M.) To some unknown extent, the presence of rock groins on the beach may diminish the value of the recreational beach for some visitors.

The Applicant's fourth stated project purpose is to restore the sandy beach to maintain and enhance marine turtle nesting habitat. The T-Head Groin and Reduced Fill Alternative would not create a sandy beach as extensive as that proposed in the Applicant's Preferred Alternative. Furthermore, with a significantly greater renourishment frequency, the T-Head Groin and Reduced Fill Alternative may increase the risk of marine turtle nesting interference or failure associated with the formation of scarps following dredged material placement. Even if the renourishment frequency were equal to that of the Applicant's Preferred Alternative, the installation of groins is not expected to substantially improve the beach for marine turtle nesting. In fact, the presence of rock groins on the beach may diminish potential nesting habitat in the area of the groins and interfere with marine turtle migration into the Project Area. Overall, the T-Head Groin and Reduced Fill Alternative does not appear to be feasible to meet the Applicant's stated project purpose.

Finally, the added cost of groins in the Phipps Project area is not justified by any benefits afforded. Not only is there no meaningful reduction in total re-nourishment volumes over the 50-year project life, the T-Head Groin and Reduced Fill Alternatives so substantially increase

the re-nourishment frequency as to offset whatever slight reduction (just over 1 acre) in the direct and immediate impact to nearshore hardbottom resources. In addition, over the project life, the no reduction in impacts to hardbottom is questionable. Finally, it is noteworthy that any reduction in the acres of hardbottom impacted by the fill is attributable solely to the reduction in the volume and length of the fill placement area. The groins themselves do not contribute to the reduction of hardbottom impacts at all nor do the groins effectively retain the limited sand placed. When examined as a whole and accounting for the impacts over the project life, the groins produce no significant benefit that would justify the \$1,500,000 estimated construction cost of the groins or the almost three-fold increase in dredging operations.

6.0 ENVIRONMENTAL CONSEQUENCES

6.1 Tides, Winds, Currents and Waves

The T-Head Groin and Reduced Fill Alternative will not significantly or quantifiably impact tides, winds, current, or waves in the Project area. As described in section 4.1.3, the background forces shaping the shoreline are not altered by the placement of sand or construction of rock groins. Added sediment would temporarily increase the beach profile and provide added storm protection and habitat. Installation of structures would increase sand retention slightly, but over the long-term, the limited fill performance is not significantly better with the structures than without the structures due to the overwhelming longshore transport deficit in the Project Area. The wave climate may be altered in the vicinity of the borrow area following dredging.

6.2 Beach and Inlet Geology and Geomorphology

The T-Head Groin and Reduced Fill Alternative is not expected to have any quantifiable impact on beach and inlet geology or geomorphology over the long-term in the area between Lake Worth and South Lake Worth Inlet. The construction of rock groins would create new near shore rock habitat when exposed; however, the new habitat is relatively insignificant in the inlet-to-inlet region. As quantified below, construction of groins in the Project area would have a direct impact on some existing nearshore hardbottom resources.

6.3 Sediment Characteristics of Borrow Area and Native Beach

The three T-Head Groin and Reduced Fill Alternative concepts require placement of 750,000 to 805,000 cubic yards of beach-compatible sand. As with the Applicant's Preferred Alternative, sand would be pumped by hydraulic dredge from the same designated offshore borrow area onto the beach. As described in Section 3.3, the resulting beach will have slightly different sediment characteristics than the native beach; however, no adverse environmental consequences are expected with regard to the quality of the borrow area sediments. The sediment characteristics of the primary borrow area have been reviewed and conform to the provisions of Chapter 62B-41, Florida Administrative Code (specifically, 62B-41.007(2)(j)).

6.4 Beach and Dune Vegetation and Wildlife

The T-Head Groin and Reduced Fill Alternative would have no impact to the beach and dune vegetation or wildlife resources within the Project Area. Sand placement on the beach would not directly impact the nearby dune communities or wildlife. While not as effective as the Applicant's Preferred Alternative, the placement of the sand material on the beach along with the associated T-head groin structures would act as a temporary buffer against storm surge damage to dunes and dune vegetation under moderate storm conditions. Dune community wildlife would not be substantially impacted positively or negatively by construction of the T-Head Groin and Reduced Fill Alternative.

6.5 Threatened and Endangered Species

The T-Head Groin and Reduced Fill Alternative would have temporary and potentially long-term impacts to some threatened and endangered species. In the short-term, marine turtle nesting success on the nourished section of the beach may be impacted directly following construction, but should normalize within one to three years following construction. Because the fill volume of this alternative is 46% to 50% less than the Applicant's Preferred Alternative, some of the negative impacts of beach fill construction can be expected to be less. However, because the nourishment frequency for the T-Head Groin alternatives is increased three-fold, the number of construction events impacting marine turtle nesting would increase from 6 to 16 events over the 50-year project life.

To some unknown extent, the construction and maintenance of T-head groins along the beach may alter long-term sea turtle nesting and migration patterns throughout the project area. The T-head groins would also alter the nearshore habitat areas important to sea turtle nesting and foraging and while limited in scope, these impacts could be both positive and negative.

Even with the reduced fill placement associated with the three variations of the T-Head Groin and Reduced Fill Alternative, placement of material on the Town's beaches would temporarily impact threatened and endangered species and efforts will be taken to greatly minimize these impacts. On the Atlantic shoreline of Florida, sea turtles typically nest between April and August, with late season nest deposits resulting in emergent hatchlings extending into late October. In similar projects on the Atlantic shoreline, nesting densities north and south of the fill area have been shown to increase, implying that nesting may be displaced from the fill area, but not necessarily reduced overall. It has also been found that following some beach nourishment projects, there is no reduction in nesting density even within the fill area itself. Bagley et al. (1994) and Ehrhart et al. (1994) both discuss the effects of beach nourishment on emergence success on nourished beaches. Specifically they address scarp formation and its affect on turtle emergence. They found an increase in nesting on nearby beaches. They postulate that the turtles that tried to nest on the nourished beach and could not, then nested on the closest available suitable beach. Crain et al. (1995) also summarizes these two papers and draws this conclusion.

State and federal regulatory agencies require that construction be limited to a time period outside of the nesting season (1 November to 1 March) in order to minimize impacts to nesting and hatchling sea turtles. Construction activities are scheduled outside of the prime-nesting season of sea turtles; thus minimizing impacts to sea turtle nesting. Most Project impacts on sea turtle nesting success are expected to be limited to the first year, with some effect persisting into the second year.

The potential negative impacts of beach nourishment activities on marine sea turtle nesting are described In Appendix C, Cumulative Impact Assessment Report. In addition, the USACE has also identified the potential consequences of nourishment activities on sea turtle nesting in the environmental review of Federal beach restoration projects on the southeast Florida coast. In the Final Environmental Assessment, "Renourishment at Miami Beach in the Vicinity of 63rd Street, Beach Erosion Control and Hurricane Protection Project, Dade County," the USACE-Jacksonville District noted, "Beach nourishment and associated activities have the potential to impact sea turtles and may have the following effects:

- a. Scarp development leading to hindrance or blockage of accessibility to nesting habitat;
- b. Adverse alteration of moisture levels or temperature in beach due to modified nesting material;
- c. Compaction and cementation of beach sediments that cause reduced nesting success and aberrant nest cavity construction resulting in reduce nesting and/or hatching success;
- d. If carried out during the nesting season, there is a potential for the destruction of nests that are not identified during the daily nest survey and relocation program; and
- e. Disruption of nesting activities that could lead to poor nest site selection and energetic cost diminishing egg production."

However, nests laid on renourished beaches generally hatch successfully (Nelson and Dickerson, 1988). Herren (1999) found no significant difference in hatching success in the renourished area in the first or second season after a sand transfer renourishment at Sebastian Inlet, Indian River County. Ecological Associates Inc. (EAI, 1999) found lower overall hatch success on nourished beaches following construction compared to controls, but the differences were not statistically significant. Indirect impacts that may be associated with placement of material on the beach may include unusual nest placement, scarping, temperature effects, and increased numbers of false crawls. The EAI study did show changes in incubation environment, but these changes did not affect the hatching success. The primary source of impact was erosional losses of low-lying nests on the newly constructed berms (EAI, 1999; Herren, 1999). A proper relocation program could significantly reduce this source of impact. Details of measures being taken to reduce these impacts are detailed in Appendix F, Part IV.

Assuming permit conditions are imposed on this supplemental alternative similar to those required in the FDEP permit for the Applicant's Preferred Alternative, (see Appendix F,

Physical and Biological Monitoring Program), the T-Head Groin and Reduced Fill Alternative and post-construction monitoring/response program would adequately addresses the potentially negative impacts of the reduced fill on nesting sea turtles. In addition, to the extent the fill volume itself creates negative impacts on nesting sea turtles, the T-Head Groin and Reduced Fill Alternative can reasonable be expected to have fewer negative impacts upon nesting turtles.

Similar to the USACE's conclusions reached regarding the Federal projects planned for the Phipps Ocean Park area in 1987 and 1996, periodic beach nourishment can, on balance and considering other potential impacts on turtles, preserve and enhance marine turtle nesting areas on eroding shorelines. It can be expected that to some extent, the T-Head Groin and Reduced Fill Alternative will increase the dry beach area suitable for nesting and improve turtle access to the dry beach in areas that are currently inaccessible due to the exposed rock "cliffs" and rock "fields." Conversely, because this supplemental alternative would create a smaller, less persistent dry beach area when compared to the Applicant's Preferred Alternative, there would be little long-term increase in available marine turtle nesting areas and the interference of the groins with turtle migration and access may offset any benefit that may occur as a result of the fill placement.

However, as stated with respect to the Applicant's Preferred Alternative, it is important to recognize that marine turtle nesting success is a complex natural dynamic and depends on multiple factors, including beach temperature, scarp formation, and sand grain size and compaction. Simple cause and effect conclusions regarding the impact of the T-Head Groin and Reduced Fill Alternative are therefore difficult to draw.

The construction of T-head groins will, to some localized extent, alter the nearshore environment and create new substrate for establishment of marine flora and fauna. While very little data exists on the seasonality of use and dietary habits of juvenile turtles within this area, it is believed foraging juvenile green turtles may utilize nearshore habitats similar to those within the Phipps Project Area. Green turtles typically develop in habitats that are shallow, protected waters where seagrasses are prevalent (Carr et al. 1978), but small green turtles are also commonly found in reef environments where attached algae is present (Ehrhart et al. 1996) (Coyne 1994). It has been suggested that green turtles in foraging habitats may tend to specialize in either algae or seagrass forage, as individual turtles with intestinal microbial flora adapted to aid in seagrass digestion would digest algae less efficiently, and vice versa (Bjorndal 1985). University of Central Florida researchers along the Indian River County coast have done some preliminary work on this subject, but published data is not yet available. Construction of T-head groins along the nearshore areas of Phipps Ocean Park may increase juvenile marine turtle foraging areas and have a positive impact on these activities. However, considering the large amount of similar habitat available outside of the project area and the requirement that the Applicant construct a mitigation reef six months before the beach fill, impacts to foraging habitat – either positive or negative -- should be temporary and minimal.

Consistent with established Federal practices governing beach restoration projects, impacts to other species such as the least tern, and piping plover will be minimized by timing the construction activities outside of the main breeding season, which peaks in late summer.

In the final analysis, the intended environmental benefit of the T-Head Groin concept – a desired reduction in the nearshore hardbottom impacts – is very limited. Under the best case scenario, the 3.1-acre impact to hardbottom resources from the Applicant's Preferred Alternative can be reduced to a 2.01-acre impact for T-Head Groin Concepts 1 and 3 (see Table M-2). There is essentially no reduction in hardbottom impacts associated with Concept 2. The environmental benefit of this modest reduction in hardbottom impacts is likely to be outweighed by the greater impact to T&E species and other natural resources associated with a three-fold increase in the renourishment frequency.

6.6 Offshore Borrow Area Resources

Overall, the impact of the T-Head Groin and Reduced Fill Alternative on offshore borrow area resources is difficult to assess. Because the fill placement volume is at least 46% less, depending on the concept selected, than that for the Applicant's Preferred Alternative, the impact to offshore resources for construction of the initial project can be expected to be less. However, because the renourishment interval for this alternative is three years, as opposed to eight years for the Applicant's Preferred Alternative, the cumulative impact to offshore borrow area resources may actually exceed that of the Applicant's Preferred Alternative.

Dredging, such as that proposed in this project, has spatially and temporally limited impacts to benthic infaunal communities and sessile epifauna. In some cases, the bottom topography of borrow areas outside the depth of closure may be altered for extensive periods of time. However, most studies on the infauna of sand borrow areas have shown little lasting impact in terms of species diversity and total abundance or density. Previous studies have shown dredging to have little long-term adverse effects on benthic habitats (Culter and Mahadevan, 1982; Saloman et al., 1982; Hammer, et al., 2000). Johnson and Nelson (1985) found that abundance and species richness returned to near normal 9-12 months after dredging off Fort Pierce Inlet in the same general location as the proposed Project. Similar results were reported by Saloman et. al. (1982) off Panama City Beach, Florida and by Tuberville and Marsh (1982) in Broward County. Benthic infauna should be expected to start re-colonizing these areas within days after dredging is completed. As identified in Appendix G, Vessel Operations Plan, the side-slope of the borrow areas, consistent with accepted industry standards, will be approximately 1V:3H. The calculation of borrow area material volume takes into account the 1V:3H slope required in the Vessel Operations Plan. The cross-sections of the borrow areas are included in Appendix L, FDEP Permit.

Silt content in the borrow area can also impact benthic community re-colonization. Barry A. Vittor and Associates, Inc. (1999) found that the amount of silt/clay present within sediments and the location of the offshore borrow area can, in some conditions, delay the recovery time of benthic infauna following dredging. Since very little fine material (silt/clay) is present within the borrow areas identified by the Applicant, the presence of fine material is unlikely to impact benthic re-colonization rates and recovery should occur rapidly within the borrow

areas identified by the Applicant. Based on a review of current published data, it is estimated that infaunal assemblages within the Phipps borrow areas will become re-established within 12 to 24 months of dredging. The Vessel Operations Plan includes requirements governing dredging practices, which will help aid in the re-colonization of benthic organisms.

Over the 50-year project life, the number of dredging events necessary to support the T-Head Groin and Reduced Fill options is 16 compared to the 6 dredging events necessary for the Applicant's Preferred Alternative. While the volume of sand dredged per event is about one-half of that of the Applicant's preferred volume, the environmental benefit of this reduction is virtually erased over the life of the 50-year project life (see Table 1). Most importantly, the frequency of the borrow area disturbances under the T-Head Groin options is so substantially greater as to outweigh whatever benefit may be gained by reducing the volume of sand dredged per event.

6.7 Hardbottom Resources

For all three T-Head Groin and Reduced Fill concepts evaluated, fill placed in the southern half of the Project area would directly impact the same areas and acreage of nearshore hardbottom resources when compared to the Applicant's Preferred Alternative. This impact is unavoidable because the majority of the hardbottom in this area is intertidal and immediately subtidal of the beach between MHWL and -2 to -3 feet NGVD. Even if the fill volume between DNR Monument R-119.25 extending south to R-126 is reduced by 50%, all nearshore hardbottom in this reach would be effectively buried by all three T-Head Groin and Reduced Fill concepts. In addition, hardbottom that is within the footprint of the groins and the subsequent tombolo formation area on the north side of the groins would be directly impacted and buried.

Fill placed north of the central groin from DNR Monument R-119.25 to R-116 would directly impact some nearshore hardground resources, but to a lesser extent when compared to the Applicant's Preferred Alternative. As presented in Table 1, Concepts 1 and 3 would impact 2.01 acres of hardground resources compared to the 3.1 acres impacted by the Applicant's Preferred Alternative, representing a reduction of about 35% in hardbottom impacts. Concept 2 would impact 3.08 acres of hardbottom resources, less than a 1% reduction in impact when compared to the Applicant's Preferred Alternative.

Table M - 2 Comparison of Hardbottom Impacts, Applicant's Preferred Alternative vs. T-Head Groin Concepts 1 - 3		
T-Head Groin Concept	Hardbottom Impacts	Percentage Reduction of Hardground Impact vs. Applicant's Preferred Alternative
Applicant's Preferred Alternative	3.1 acres	N/A

Concept 1- No Fill in North Half	2.01 acres	64.8 % Impact Reduction
Concept 2 - Minimal Fill North Half	3.08 acres	Less than 1% Impact Reduction
Concept 3- Minimal Fill in North Groin Field	2.01 acres	64.8 % Impact Reduction

Hardbottom impacts for the three T-Head Groin and Reduced Fill concepts were estimated using the identical time-averaged method used to calculate the total hardbottom impacts for the Applicant's Preferred Alternative

6.8 Essential Fish Habitat

All three T-Head Groin and Reduced Fill concepts would impact open sand, hardbottom, and open water habitats. The hardbottom communities within the project area are designated as EFH-HAPC by the SAFMC (1998). Depending on the T-head groin concept selected, between 2.01 and 3.08 acres of hardbottom habitat would be impacted by implementation of the T-head groin alternative. The addition of structures would create additional hardbottom habitat within the area impacted. While this would not totally replace the natural habitats lost, it would over time help to mitigate any losses attributed to this alternative. The proposed toe of fill would also temporarily impact approximately 57 acres of open water habitat along the Project area occurring from the MHW line and extending approximately 150 feet offshore. These temporary impacts would include displacement of fishes and some invertebrates from nearshore areas during dredging and fill placement. Other impacts include temporary loss of water quality due to turbidity and decreased primary productivity until the completion of nourishment. Because the renourishment frequency for the three T-head groin concepts is every three years, the impact to water quality and EFH resources can be expected to be as great or greater over the life of the project when compared to the Applicant's Preferred Alternative.

6.9 Coastal Barrier Resources

The purpose of the Coastal Barrier Resources Act is to minimize the loss of human life, wasteful expenditure of federal funds, and damage to fishes, wildlife, and other resources associated with the coastal barriers along the Atlantic coast. This is implemented by restricting future federal expenditures and financial assistance, which have the effect of encouraging development of these coastal barriers. There are no designated Coastal Barrier Resource Act Units located within or adjacent to the Project area.

6.10 Water Quality

For the T-Head Groin and Reduced Fill Alternative, direct impacts to water quality resulting from the dredging of material from the borrow area and subsequent beach disposal are likely to be greater than the water quality impact of the Applicant's Preferred Alternative over the life of the project but be minimal. During beach sand placement operations, elevated

turbidity at the edge of a 150-meter mixing zone originating from the point of discharge of fill material onto the beach can be expected.

It is typical for beach fill projects on the open coast to be granted a variance to the mixing zone criteria in FAC 62-4.244; the proposed Phipps project is not unique and such a variance would likely be requested for the T-head groin alternative. The concept of a mixing zone was developed principally for discharges into receiving waters that either had unidirectional flow (riverine) or simple tidal forcing (estuarine), and also typically for a static point of discharge. Special challenges exist when the discharge of a conservative constituent, especially sediment, takes place into a water body that exhibits both tidal forcing and wave action (ocean), and for a discharge point that moves daily. Wave action produces onshore-offshore water movement as a result of induced water column orbital velocities, as well as alongshore water movement as a result of the incident angle of the waves with respect to the shoreline. The magnitude of the orbital velocities may vary greatly depending on the wave heights at the time and incident wave angles may vary over the entire range of possible offshore directions of approach. As a result, and with the concurrent variability of tidal stage and tidal current direction, all the forces and water movement components may reinforce each other causing much greater potential suspended sediment transport than any single element might by itself. In addition, because of the directional variability of each factor, the entire regime is in effect oscillatory and therefore requires not only an expanded mixing zone size, but also one applied in both directions from the moving point of discharge.

Even with the substantial reduction in fill volumes associated with the T-Head Groin and Reduced Fill Alternatives, there may be no practical means known to further minimize the potential for elevated turbidity using the borrow material selected and considering hydrodynamic processes in the nearshore area at the beach nourishment site. Similar to the Applicant's Preferred Alternative, beach nourishment work for the T-Head Groin Concepts would be undertaken in a manner that minimizes the potential for elevated turbidity, including the use of construction dikes and a minimum setback for the discharge pipe from open water at the beach. A turbidity-mixing zone of 300 meters offshore and 1,000 meters alongshore from the point of discharge has been approved by the FDEP staff for the Applicant's Preferred Alternative and would be requested for the T-Head Groin Alternative. If granted, turbidity would be monitored during the beach disposal work to ensure compliance at these limits.

Because of the almost three-fold increase in the renourishment frequency, the temporary increase in turbidity resulting from the borrow area and beach placement operations would likely exceed that of the Applicant's Preferred Alternative, over the 50 year project life. However, the nearshore outcrops are already subject to periodic increased turbidity by storms and wave activity. As a result, the biological communities that inhabit this nearshore zone are made up of stress-tolerant, opportunistic species. The T-Head Groin Alternative would also cause more frequent but still temporary increases in turbidity at borrow area sites. The rock material necessary to construct the t-head groins would be clean and free of any significant amount of fine or silty material. However, there may be some slight elevation of turbidity in

the immediate groin construction area. There may also be some disturbance of the bottom sediments as the rock hits the ocean bottom, causing some minimal turbidity.

The State of Florida water quality regulations require that water quality standards not be violated during dredging operations. The standards state that turbidity outside the mixing zone shall not exceed 29 NTU's above background. Results from turbidity monitoring at previous beach nourishment projects have shown that the turbidity does not typically exceed the standard. Various protective measures and monitoring programs would be conducted during construction of the T-Head Groin Alternative to ensure compliance with State water quality criteria. Should turbidity exceed State water quality standards as determined by monitoring, the contractor would be required to cease work until conditions returned to normal. Use of upland sources would not have the impacts associated with dredging an offshore borrow area, but would have the same impact along the beach fill area.

6.11 Hazardous, Toxic, and Radioactive Waste

Implementation of T-Head Groin and Reduced Fill Alternative will have no impact on HTRW within the study area

6.12 Air Quality

Direct emissions from the T-Head Groin and Reduced Fill Alternative would be confined to exhaust emissions of labor transport equipment (land and water vehicles), and construction equipment (dredge barges). These emissions would likely be well under the *de minimus* levels for ozone non-attainment areas as cited in 40 CFR 91.853; that is, projects implemented cannot produce total emissions greater or equal to 100 tons/yr of Volatile Organic Compounds (VOCs). Any indirect increase in emissions (indirect emissions), as a result of the proposed action is beyond the control of the Town and USACE. Consequently, a conformity determination with the Florida State Implementation Plan is inappropriate for increases of indirect emissions from the proposed action. The extent of these impacts, however, is difficult to predict.

6.13 Noise

Similar to the Applicant's Preferred Alternative, there would be a temporary increase in the noise levels during construction of the T-Head Groin and Reduced Fill Alternative. The noise level increase would be more frequent for the T-Head Groin Alternative because of the almost three-fold increase in the renourishment frequency. The principle noise would stem from the vicinity of the discharge point on the beach, the mitigation reef construction site and the dredge. Construction equipment would be properly maintained to minimize the effects of noise. Increases from the current noise levels would be localized and minor, and limited to the time of construction

6.14 Aesthetic Resources

The T-Head Groin and Reduced Fill Alternative will adversely impact the aesthetics of the Project Area during construction. Hundreds of feet of dredge pipe lying on the beach or just

offshore every three years would have a temporary negative visual impact on the aesthetics of the area. This impact would be eliminated with removal of the pipe at the completion of the work. The negative visual impacts of the equipment and pipe would be offset in part by the natural curiosity of some individuals observing how work is progressing. There would also be a temporary increase in turbidity during construction adjacent to the point of discharge. Turbidity would return to normal levels once construction activities cease. No definitive assessment of the aesthetic impact of the T-head groin field can be offered, as it is a matter of personal taste and preference, however, a natural beach uncluttered by rock groins is appealing to many citizens.

As with the Applicant's Preferred Alternative, the beach fill material itself will appear slightly gray in color when initially placed, but it will lighten after placement, drying, exposure to air, and "bleaching" by the sun. It is likely FDEP would require that any escarpments or excessive coarse gravel placed on the beach be removed.

6.15 Recreational Resources

The impact of the T-Head Groin and Reduced Fill Alternative on recreational resources can be attributed to two important factors: (1) the three-year renourishment interval and (2) the construction of a groin field in the project area. During nourishment activities, the use of the beach in the immediate area of the discharge pipe and equipment can be expected to drop or be restricted temporarily for public safety reasons. Noise from the heavy equipment needed to spread and smooth the sand would disturb some beach users outside of the restricted areas. Many visitors would seek quieter areas for sunbathing or swimming. As portions of the renourished beaches become available, use by the general public can be expected to increase once more. The expanded dry beach, while narrow and relatively short-lived, will create more space for visitors interested in beach recreational activities, such as sun bathing, volleyball, kite flying, and similar activities.

Construction of a groin field on the beach can impact recreational activities positively or negatively, depending on the activity undertaken and the preferences of the participants. For those interested in uninterrupted beach areas for beach combing, walking, sight-seeing or similar activities, the groins spaced 250 feet apart would interfere with these activities to some indeterminate extent. However, visitors interested in fishing or snorkeling may find the groins a positive addition to these activities. There could be a temporary adverse effect on recreational fishing in the immediate area of beach fill operations and at the borrow area due to relatively frequent construction activities and resulting increase in turbidity. Fishing would not be affected outside the area of immediate construction. Boat operations may be detoured during construction activities; however, the extent of these detours and time frame of operations render these impacts insignificant.

Upon completion of the T-Head Groin Alternative, use of the Project Area by the general public and those who stay at the nearby condominiums and hotels can be expected to rapidly return to pre-project activity levels and increase over time.

6.16 Cultural Resources

The impact of the T-Head Groin and Reduced Fill Alternative on cultural resources is expected to be minimal and may be non-existent. Archival research and field investigations of the borrow areas were conducted by CP&E in March 2000 (See Section 1.6, Report j). In Borrow Area IV, three magnetic anomalies were identified that generally exhibit characteristics consistent with those of historic submerged cultural resources. However, the magnetometer signatures within the borrow areas have not been identified as cultural resources. As a precaution, in case these anomalies are a cultural resource, a 200-foot buffer would likely be imposed by FDEP on the dredge operation, eliminating potential impact to these areas. In Borrow Area III, one magnetic anomaly cluster was detected at the approximate location of a charted and inactive outfall pipeline. Similar to the restrictions imposed by FDEP on the Applicant's Preferred Alternative, a 100-foot buffer area would likely be established to avoid impacts to this cluster.

6.17 Health and Safety

No significant health or safety concerns have been identified with respect to the T-Head Groin and Reduced Fill Alternative. During construction, appropriate signage warning of temporary conditions unsuitable for visitors will be placed as required or applicable. Following construction of the groins, visitors would need to exercise a reasonable degree of care to avoid falls or injuries that can occur while climbing on and over rock groins, especially during elevated tide and wave conditions.

6.18 Energy Requirements and Conservation

The energy requirements for T-Head Groin and Reduced Fill Alternative would be confined to fuel for the dredge, labor transportation, and other construction equipment. Similar to the Applicant's Preferred Alternative, the expenditure of energy would be much less if sand material was obtained from the designated nearshore borrow areas rather than other potential sand sources described in Section 2.2.2. Because of the more frequent renourishment frequency required for the T-Head Groin Alternative, fuel and energy consumption over the project life would likely equal or exceed that of the Applicant's Preferred Alternative.

6.19 Natural or Depletable Resources

As with the Applicant's Preferred Alternative, the beach quality sand used to construct the T-Head Groin and Reduced Fill Alternative is a depletable resource. Using sand from the proposed borrow area will deplete the sand source from the areas dredged at that site. Eventually the sand will be redistributed over nearshore areas. It is unlikely that the redistributed sand will return to the same location from which it was removed, resulting in a depletion of resources in the borrow areas. The gasoline and diesel fuel used by the dredge and other construction equipment is also a depletable resource.

6.20 Cumulative Impacts

The direct impacts from past, present and proposed beach restoration activities on the nearshore hardbottom resources within the Project Impact Zone, Proposed Project Zone, and Regional Institutional Zone are summarized in Section 4.20 and Table 4.1 of the SEIS. A thorough Cumulative Impact Report is located in Appendix C and, while the T-Head Groin and Reduced Fill Option differs from the groin structure evaluated therein, the Cumulative Impact Report addresses the issues associated with the restoration of Phipps Ocean Park Beach.

6.20.1 Hardbottom Summary

The hardbottom in the Project area is composed in part of sessile organisms including macro algae, sponges, sabellariid worm rock, and to a lesser extent soft and hard corals. Depending on the concept selected, the T-Head Groin and Reduced Fill Alternative will impact 2.01 to 3.08 acres of nearshore hardbottom. Because this hardbottom is immediately adjacent to the shoreline, dredging-associated impacts to this habitat are deposition, resulting in the burial of the algal, sponge, and coral community. By reducing the fill volume in the north end of the Project Area, this alternative does reduce the total hardbottom impacted when compared to the Applicant's Preferred Alternative. While the area impacted is less, there is not expected to be a significant difference between the nature of the impact to nearshore hardbottom for the T-Head Groin and Reduced Fill and the Applicant's Preferred Alternative. In both cases, additional secondary impacts could include downdrift movement of sediments; elevated suspended solids that would reduce algal production (due to reduced light levels) and could interfere with the ability of corals to feed heterotrophically; and diminished biological integrity and diversity. Because of the more frequent renourishment required for the T-Head Groin and Reduced Fill Alternative, these secondary impacts will occur more often and may, over the life of the project, equal or exceed the secondary impacts associated with the Applicant's Preferred Alternative.

6.20.2 Sand Habitat Summary

Removal of at least 750,000 cubic yards of sediment from offshore borrow areas will be necessary for construction of the T-Head Groin and Reduced Fill Alternative. This dredging operation will directly impact the sand habitat including both the infaunal and epifaunal community. Initially this will result in a significant, but localized, reduction in the abundance, diversity, and biomass of the immediate fauna. Species affected most are those that have limited capabilities or are incapable in avoiding the dredging activities. The fauna most affected will include predominately invertebrates such as crustaceans, echinoderms, mollusks, and annelids, as well as finfish larvae. However, due to the relatively small area that will be impacted as viewed on a spatial scale, impacts to the benthic community will be minimal due to the relatively short period of recovery documented for infaunal communities following dredging activities (Culter and Mahadevan, 1982; Saloman et al., 1982). Adjacent areas not impacted will most likely be the primary source of recruitment to the impacted area. Similar to the Applicant's Preferred Alternative, dredging and vessel management practices would be employed to avoid and minimize any impacts associated with this offshore dredging

operation. For example, to minimize any adverse effects to beach fauna, the T-head Groin and Reduced Fill Alternative could be conducted during the winter months, outside the recruitment window for many impacted species, and a high quality source of sand containing a small percentage of fine material will be used. While the dredging frequency is every three years, it is not expected that the T-head Groin and Reduced Fill Alternative will have any significant, long lasting impacts on the beach sand infaunal communities.

6.20.3 Significance of Cumulative Affects

Compared to the Applicant's Preferred Alternative, the T-head Groin and Reduced Fill Alternative would reduce the impacts to nearshore hardbottom communities by as much as 65%. However, due to the paucity of actual research and long-term monitoring on nearshore hardbottom communities, determining the significance of the cumulative impact of sand placement on these nearshore communities is difficult. Past impacts within the Regional Institutional Zone do not appear to have had any adverse or significant cumulative impact on the resource. Proposed future actions within the County do add cumulatively and are adverse. Due to the significant amount of adjacent habitat remaining, however, it is safe to assume that the hardbottom habitat has not reached carrying capacity for the indigenous marine algae, fishes, or macroinvertebrate fauna and that a small reduction in the amount of habitat will not adversely affect populations of these species. With this in mind, the impacts of the T-head Groin and Reduced Fill Alternative, while they are likely to be considered adverse, are not expected to be significant, since the adjacent habitat is clearly not limited for commonly occurring fishes and invertebrate species. Post-project monitoring of the project area would be essential to provide information on the actual extent of spatial and temporal indirect affects of the T-head Groin and Reduced Fill Alternative, particularly given the frequent renourishment period required for this option. Information focusing on the response of the hardbottom community to disturbances could be highly beneficial in determining whether additional projects implemented in the County or region would have a significant cumulative affect. A reassessment of cumulative affects should be performed based on scientific monitoring prior to implementation of each proposed project.

6.21 Irreversible and Irretrievable Commitment of Resources

6.21.1 Irreversible

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. Federal NEPA guidance issued by the Council on Environmental Quality offers several illustrations of irretrievable resource commitments such as the mining of a mineral resource or combustion of petroleum products. The relocation of sand resources from the borrow areas to the placement areas for the T-Head Groin and Reduced Fill Alternative may irreversibly deplete offshore sand reserves to some unquantifiable extent. Because of the three-year renourishment cycle necessary for T-Head Groin and Reduced Fill Alternative (and depending on other factors such as longshore transport rates and storm conditions), the offshore sand resources may not replenish fast enough to sustain the renourishment projects over the long-term. The energy and fuel used during construction of

the T-Head Groin and Reduced Fill Alternative would also be an irreversible commitment of resources.

The T-Head Groin and Reduced Fill Alternative may have an equal or greater impact on the depletion of sand resources in the borrow areas, when compared to the Applicant's Preferred Alternative. While the initial construction volume is reduced to about one-half the volume necessary for the Applicant's Preferred Alternative, the more frequent renourishment cycle over the life of the T-Head Groin and Reduced Fill Alternative will result in substantially greater disturbance of the offshore borrow areas.

Like the Applicant's Preferred Alternative, the T-Head Groin and Reduced Fill Alternative can be expected to be indefinitely maintained. While continuous coverage of nearshore hardbottom resources can be expected once the project is initiated, the burial of nearshore hardbottom cannot be fairly characterized as an "irreversible" commitment of resources. The underlying nearshore rock, which is naturally buried and unburied at various times of the year, is not irreversibly lost because if the project were cancelled or suspended for any reason -- be it financial, regulatory, or simply a shift in local priorities -- the hardground resources impacted by the project would eventually be re-exposed without any human intervention, as the erosive forces begin again to operate unchecked. Renourishment activities, subject to permitting and funding availability, cannot be guaranteed. The waves and tides on the shoreline would, as in the past, erode the shoreline landward and the rock coverage would be "reversed." In 1987, the USACE recognized the reversibility of hardbottom burial in reference to the Palm Beach Island Beach nourishment project. The Corps concluded, "(Fill material) could be removed at any time by allowing the nourished beach to erode by discontinuing periodic nourishment." (See 1987 Palm Beach Island GDM/EIS, Table 4, page 48, regarding "reversibility" of nearshore hardbottom impacts).

6.21.2 Irretrievable

An irretrievable commitment of resources is one in which, due to decisions to manage the resource for another purpose, opportunities to use or enjoy the resource as they presently exist are lost for a period of time. One example of an irretrievable loss of a resource would be where a specific type of vegetation is lost due to construction or a road project. Similarly, benthic organisms within the borrow area and beach fill area that would be eliminated during construction would be irretrievably lost for a period of time. However, the high rate of repopulation expected from these organisms reduces the significance of the loss.

Depending on the concept selected, the T-Head Groin and Reduced Fill Alternative would unavoidably result in a commitment of 2.01 to 3.08-acres of nearshore hardground resources. This resource commitment can be considered "irretrievable" to the extent that the project is maintained over time. Appropriately, mitigation for this impact would likely be required by construction of a mitigation reef equal in size to the hardground resources impacted by the T-Head Groin and Reduced Fill Alternative.

6.22 Unavoidable Adverse Environmental Effects

The T-Head Groin and Reduced Fill Alternative would result in some unavoidable adverse environmental effects similar to those resulting from the Applicant's Preferred Alternative. These impacts are unavoidable to some extent because the T-Head Groin and Reduced Fill Alternative still requires the dredging and placement of about 750,000 cubic yards of sand and these operations create some unavoidable adverse environmental effects. For example, species of relatively non-motile infaunal invertebrates that inhabit the borrow areas will unavoidably be lost during dredging. Those species that are not able to escape the construction area can be expected to recolonize the area after project completion, although the borrow areas will be disturbed about every three years as renourishment activities occur. There would also be a temporary but unavoidable reduction in water clarity and increased turbidity and sedimentation during initial construction and frequent dredging for renourishment of the beach. Generally, the adverse water quality impacts would be limited to the immediate areas of dredging, beach fill operations, and mitigation reef construction, if required. While this impact will be temporary and should disappear shortly after construction activities cease, the three-year renourishment requirement will cause significantly more frequent impacts as compared to the Applicant's Preferred Alternative.

Finally, there could also be unavoidable impacts to hardbottom benthic organisms due to placement of pipelines across the sand and nearshore rock outcrops and due to the direct burial of nearshore hardground resources within the project area. Measures such as construction of a mitigation reef will likely be required to minimize and compensate for these impacts.

6.23 Short-Term Uses and Maintenance/Enhancement of Long-Term Productivity

The restoration of an eroding sandy beach is rarely a one-time event, instead usually requiring a continual effort to replace sand lost from the shoreline over the life of the project. The T-Head Groin and Reduced Fill Alternative is expected to have a renourishment interval of three years, compared to the eight-year interval for the Applicant's Preferred Alternative or four years for the Federal project evaluated by the USACE in the COFS. Accelerating the renourishment frequency to a three-year cycle can be expected to increase the net environmental consequences associated with dredging and placement of sediments over the project life. In the short-term, required renourishment activities will have a temporary impact on the biological resources in the vicinity of the borrow area and shoreline. In addition, the T-Head Groin and Reduced Fill Alternative is unlikely to result in any enhancement of long-term productivity of the project area.

If a mitigation reef were required, the reef itself can reasonably be expected to maintain or possibly enhance long-term productivity of the area to some degree, but the productivity benefits of the reef are difficult to quantify. Post-construction monitoring of the reef and nearshore hardbottom resources impacted by the project could provide valuable data and information on this issue.

6.24 Conflicts and Controversy

In recent years, resource agencies, scientists and some environmental organizations have expressed concern about the impact of beach restoration and maintenance activities on nearshore hardbottom resources, particularly on the southeast Florida coast. The controversy tends to surround three broad issue areas: (1) the extent to which beach nourishment activities impact reefs and hardbottom features and biotic communities in the borrow and placement areas; (2) the duration or permanency of the impact and the capacity of the resource to recover from perturbations caused by beach restoration activities; and (3) the cumulative effect of multiple but unrelated projects in a region of the coast.

With respect to the T-Head Groin and Reduced Fill Alternative, controversial issues include the more frequent re-nourishment cycle compared to the Applicant's Preferred Alternative and the extent to which the Applicant's stated project purposes can be met. Finally, some controversy exists over the feasibility of the T-Head Groin and Reduced Fill Alternative from both cost-effectiveness and permitting perspectives.

6.25 Uncertain Unique, or Unknown Risks

Restoration of eroding sandy shorelines through construction of T-head groins and periodic placement of sand from offshore borrow areas is an infrequent but not untried practice in Florida. Consequently, with respect to the general performance of the T-head groins and beach nourishment, there are risks that are clearly uncertain, unique, or unknown.

Burial of some nearshore hardbottom features, primarily in the intertidal and surf zones within the Project Area, is clearly an unavoidable impact if the beach is to be restored. The T-Head Groin and Reduced Fill Alternative was evaluated based specifically on the premise that it may accomplish the goals of the project while reducing nearshore hardbottom impacts. However, it is questionable whether the maximum reduction of hardbottom impact from 3.1 acres in the Applicant's Preferred Alternative to 2.01 acres in the T-Head Groin and Reduced Fill Alternative (Concepts 1 and 3) is biologically significant, particularly in light of the fact that more frequent re-nourishment events would be required to maintain the T-Head Groin and Reduced Fill Alternative.

The T-Head Groin and Reduced Fill Alternative may also result in significant negative physical and biological impacts in the vicinity of the project area since it would (a) reduce the updrift sandy beach by limiting fill on the northern reach of the project; (b) trap some volume of sand on the updrift (north) side of the groins resulting in burial of nearshore hardbottom; (c) impede net longshore sediment transport to and within the project area; (d) increase erosion on the downdrift side of the groins and, over time, in the southern portion of the project area; and (e) eventually, if the groins were fully impounded, potentially result in the creation of a bypassing sand bar seaward of the groin which could bury additional hardbottom. The risk and extent of these potential outcomes is difficult to evaluate with a high degree of certainty.

The regulatory feasibility of the T-Head Groin and Reduced Fill Alternative is also an uncertain risk of this alternative. It is questionable whether the T-Head Groin and Reduced

Fill Alternative would comply with State shoreline response standards and it is uncertain whether this alternative would be permitted by FDEP.

In accordance with Section 161.041, Florida Statutes, the Department may issue a permit for construction of groins after consideration of the potential impacts of the structures, including potential cumulative impacts, upon the beach-dune system, which, in the opinion of the Department clearly justify a permit. Applications for coastal construction permits are made to the Department upon the terms and conditions set forth in Rule 62B-041, Florida Administrative Code (F.A.C.).

It is the Department's policy to encourage and permit the use of flexible coastal structures, defined as beach and dune restoration and nourishment, whenever practical to achieve coastal protection objectives. Rule 62B-41.005 (4) of Florida Administrative Code specifically prescribes that:

“Flexible coastal structures will be used whenever practicable to achieve coastal protection objectives.”

Rule 62B-41.002 (47) of Florida Administrative Code defines “Flexible Coastal Structures” as “structures characterized by their frangible design or construction and ability to become freely assimilated into the coastal system by natural coastal processes. Typically included within this category are beach restoration and beach nourishment, dune restoration and revegetation.” Based upon the above provisions, it is likely that the Department would deny the issuance of a permit for the T-Head Groin and Reduced Fill Alternative.

Furthermore, Chapter 161 of Florida Statutes sets forth criteria for State cost sharing under Florida’s Beach Erosion Control Program. Section 161.101, Florida Statutes, prohibits the State funding of hard structures, such as groins, unless designed for erosion control or to enhance beach nourishment longevity or bypassing performance. Section 161.101(13) prescribes that:

“The department shall not fund projects that provide only recreational benefits. All funded activities must have an identifiable beach erosion control or beach preservation benefit directed toward maintaining or enhancing sand in the system. Activities ineligible for cost-sharing include, but are not limited to:

... (f) Hard structures unless designed for erosion control or to enhance beach nourishment project longevity or bypassing performance.”

The Department applies these criteria in the regulatory process. For this alternative, the primary objective of the groins is to deter sand migration to avoid impacts to nearshore hard bottom. The groins are not specifically proposed for erosion control and would be expected to diminish “beach nourishment project longevity”. As such, it is likely that the Department would deny the issuance of a permit for the T-Head Groin and Reduced Fill Alternative.

Rule 62B-41.005(5) of Florida Administrative Code specifically prescribes the broad relevant standard that FDEP would apply if the T-Head Groin and Reduced Fill Alternative were submitted for State consideration and permitting:

“Structures which interfere with the natural longshore and onshore/offshore movement of sediments *shall not be allowed* unless a net positive benefit to the coastal system can reasonably be expected to occur and mitigation is provided for any adverse impacts which may occur to the coastal system. Proposed coastal construction which is reasonably expected to have a significant adverse impact shall not be allowed (emphasis added).”

In light of the Applicant’s stated project purposes and the Project’s coastal protection objectives, it is unclear whether the Applicant could demonstrate that the T-Head Groin and Reduced Fill Alternative would produce a “net positive benefit to the coastal system,” as required by FDEP rules. Even though the project concept may well reduce the impact of the project to nearshore hardbottom resources -- which can be characterized as a “clear benefit to the coastal system” -- the installation of T-head groins is specifically intended to “interfere with the natural longshore and onshore/offshore movement of sediments” in the project area. This conflict of purpose and outcome may call into question the likelihood that the project can be permitted at the State level.

In consideration of the potential for adverse impacts, the regulatory policy of the State has generally limited the use of groins to improving the longevity of beach nourishment projects. The structures are typically located at the downdrift boundary of the beach fill to limit the end loss of sand moving into an adjacent inlet system or hardbottom resource. In the few instances where groins have not been located at the downdrift boundary of a beach fill project, the permit requires the periodic placement of dredged material from inlet sand bypassing operations where monitoring indicates erosional effects of the structures. It is unclear whether reducing the fill north of the groin field would be acceptable and, if so, how much additional sand would be required to offset anticipated downdrift impacts to the beach.

In addition, the shoreline recession predicted immediately downdrift of each of the T-head groins may be characterized by FDEP as “*a significant adverse impact*”. If this conclusion were reached, a State permit for the T-Head Groin and Reduced Fill Alternative could not be obtained. Finally, the groins can be expected to eventually create a sediment transport pathway around the seaward end of the groin that could result in the indirect burial of additional hardbottom resources located immediately seaward of the groins. This can also be characterized as “*a significant adverse impact*,” further complicating the State permitting process.

In keeping with the Department's authority to protect marine turtles, a permit for coastal construction must be consistent with the provisions of Section 370.12, Florida Statutes. The necessity for beach restoration is recognized as the preferred alternative to rigid coastal structures, especially seawalls and rock revetments. Groins may render the immediately adjacent beach unsuitable for nesting by their physical obstruction and by inducing

escarpments. These adverse impacts have contributed to the Department's past action in limiting the use of groins to circumstances where they are clearly justified by a net positive benefit to the coastal system.

Under FDEP rules, it is uncertain whether the T-Head Groin and Reduced Fill Alternative can be permitted due to the absence of clear and substantial benefits and the potential for significant adverse impacts that could render the adjacent beach and dune system unstable and the upland properties vulnerable to the effects of a coastal storm.

6.26 Precedent and Principle for Future Actions

Consideration or selection of the T-Head Groin and Reduced Fill Option is unlikely to create or establish new precedents or principles for future action. The USACE has an established record of decisions and actions with respect to all of the essential elements of the project, including the environmental considerations, evaluation of alternatives, and the means and methods for mitigation of hardbottom resources. The level of analysis in the Cumulative Impacts Assessment and Essential Fish Habitat Assessment reports is greater than for similar projects in the past, but this level of analysis is warranted in this case.

6.27 Environmental Commitments

As outlined in Section 2.0, Project Alternatives, several project design alternatives were evaluated to determine the extent to which the alternative satisfied the project purpose and need and while minimizing the potential adverse impacts to the environment. The Applicant's Preferred Alternative, Beach Fill with Periodic Re-nourishment (Alternative 3) – with the additional requirement to construct a 3.1-acre mitigation reef, met the project purpose and need with mitigation of adverse impacts. The T-Head Groin and Reduced Fill Alternative is intended to further reduce the environmental commitments associated with the restoration of Phipps Ocean Park Beach. It is expected that similar to the obligations outlined in the FDEP permit for Applicant's Preferred Alternative and any CWA Section 404 permit issued by the Corps for the T-Head Groin and Reduced Fill Alternative, the Town and contractors would be obligated to undertake specific actions and employ specified practices to avoid, minimize, or mitigate for potential adverse effects during construction activities.

6.28 Compliance with Environmental Requirements

Section 4.28 of the SEIS fully evaluates the compliance of the Applicant's Preferred Alternative with applicable environmental requirements. That analysis is not repeated in this Appendix. The reader is referred to Section 4.28.

7.0 CONCLUSIONS

The T-Head Groin and Reduced Fill Alternative is not preferable to the Applicant's Preferred Alternative for several reasons.

First, although two of the three T-Head Groin and Reduced Fill concepts appear to provide the intended environmental benefit of reduced impacts to hardbottom (up to a 1.09-acre reduction in hardbottom impact compared to the Applicant's Preferred Alternative), this environmental benefit is outweighed by the detrimental impact of the significantly increased renourishment frequency. The environmental impacts of the almost three-fold increase in required renourishment frequency must be considered. Any environmental benefit that may be gained by reducing the hardground impact of the Applicant's Preferred Alternative from 3.1 acres to 2.01 acres is offset by the direct, secondary and cumulative harm of the 16 renourishment events over the 50-year project life.

Second, to the extent that the minimally-reduced impact to nearshore hardbottom resources is of interest, it is clear that this benefit is entirely attributable to the reduced volume and length of the fill and not the construction of the T-head groins. In this circumstance, no clear and direct benefit is expected to be realized by construction of \$1.5 million T-head groins within the project area and no reduction in re-nourishment costs can reasonably be expected from their installation. In fact, the project costs over the 50-year project life are greater for all three T-Head Groin and Reduced Fill concepts when compared to the Applicant's Preferred Alternative, even *without* including the costs of the groin structures. There is no environmental or cost benefit to the construction of the groins.

Third, there is substantial uncertainty whether the T-Head Groin and Reduced Fill Alternative would be permitted by the Florida Department of Environmental Protection under the agency's current program regulations. Pursuit of this alternative is likely to substantially delay action to address erosion of this shoreline and unnecessarily risk future storm damage, as outlined in the evaluation of the No Action Alternative in Section 2.1.1.

Fourth, the T-Head Groin and Reduced Fill Alternative does not meet the Applicant's stated project purposes. Even if some purposes are partially fulfilled, the three concepts clearly do not satisfy all these objectives and not to the extent of the Applicant's Preferred Alternative. While the Corps is not bound by the project purposes as outlined by the Applicant, these considerations are an important basis for the evaluation of all alternatives reviewed in the SEIS and cannot be dismissed.

Fifth, the T-head groin structures will exacerbate downdrift shoreline recession and, over the 50-year project life, the total fill volumes for Concepts 1-3 approach and even exceed those of the Applicant's Preferred Alternative in order to maintain the beach and mitigate for this detrimental downdrift impact.

Because of the poor performance, added cost, significant increase in the renourishment frequency, detrimental impacts to the environment, disruption of public use of the beach, and the failure to meet the Applicants Project purposes, the T-Head Groin and Reduced Fill Alternative is not worthy of further consideration.